IAGLR
LAKES Letter

Where the water meets land—a look at the coastal zone.

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Protecting Great Lakes shores by not "protecting" them

by Richard K. Norton

"Shoreline protection" means different things to different people. Coastal wetlands, sandy beaches, dunes, and other natural features along Great Lakes shores naturally transform to submerged bottomlands from erosion and shoreline recession over time. That phenomenon is likely to accelerate because of increased storminess caused by global climate change. To the extent those accelerated processes amount to environmental "harms," they warrant calls for climate mitigation—efforts to reduce greenhouse gas emissions. But if you are a Great Lakes researcher concerned about such impacts, take care not to suggest that we should protect Great Lakes coastal shores through climate adaptation as well. At least, recognize that raising concerns about those impacts and suggesting the need for active response will likely be used to justify calls to "protect" Great Lakes shorelines with groins, seawalls, revetments, and other hard shoreline armoring—structures that in fact all but ensure destruction of the natural coast.

How did we get here? The recent, rapid, and extreme rise in lake water levels has prompted increased pressures to armor. Indeed, several thousand applications were submitted to the state of Michigan to install armoring structures along Michigan's Great Lakes shorelines in 2020 alone. Most were presumably installed to protect built structures, but at least some were advanced with the idea of protecting natural coastal resources as well—an argument bolstered as scientists have noted the harms being done to coastal shoreland features by climate change. As lake levels remain high, and federal funds for restoration projects flow, calls for shoreline "protection"—especially in the form of yet more armoring—are likely.

How best to respond? There may be places where engineered "natural" or "living" shorelines make sense, particularly in lower-energy settings where it is possible to both arrest erosional processes and restore (or at least approximate) natural ecological functions. But in higher energy systems, or those subject to extreme inundation, the best response ecologically is to let nature respond naturally. In such settings, it is not possible to have both; there we face the wicked dilemma of whether to armor—protecting private property at the loss of natural features—or withdraw—protecting natural features at the expense of private property.

There may be good reasons to armor to protect private property, such as the scale of development at risk or its importance to the local community's economy. Armoring, however, is expensive to install and maintain over time, it ultimately fails if not maintained, and it degrades natural coastal resources—all costs borne by the public in some fashion at some point. Alternatively, those costs and ecological harms may outweigh the benefits of armoring in any given place or time. Decisions favoring one or the other are properly made through political, planning, and legal processes where the tradeoffs involved can be fully vetted and considered. In any case, it is important to be clear that concerns about environmental impacts to Great Lakes coastal resources from climate change should not be used to justify "protecting" natural coastal shores in ways that could, in fact, destroy them.

Richard K. Norton is a professor of Urban & Regional Planning at the University of Michigan.

PRESIDENT'S NOTE:

Sailing into new waters with IAGLR

Hi. I'm Jean Adams, the 56th president of IAGLR. I started my career with the U.S. Geological Survey, Great Lakes Science Center in 1994 as a statistician and focused my professional society activities on the American Statistical Association. When I went back to school for a Ph.D. in fisheries and wildlife, I decided it was time to shift my extracurricular focus. I joined the IAGLR Board of Directors in 2019. I learned a lot about IAGLR in my first year. Then the pandemic struck.

A smooth sea never made a skilled sailor.
~ Franklin D. Roosevelt

IAGLR responded well to the pandemic. We continued to publish high-quality science in the *Journal of Great Lakes Research*, and we continued to host conferences, some virtual and some hybrid. The level of energy we devoted to governing through a crisis was both necessary and unsustainable.

To reach a port we must sail.
Sail, not tie at anchor.
Sail, not drift.
~ Franklin D. Roosevelt

I took the helm as president two months ago. Several people have asked me what I intend to accomplish during my presidency. I'll start by strengthening the connections among the high-functioning individuals that make IAGLR tick: the directors, the staff, and the committee members.

Next month, we'll meet in person for the first time since February 2020. Because all the current directors (other than me) joined the board during the pandemic, we've never met in-person. Such interactions are critical to building trust and encouraging collaboration. Together, we will establish an approach to governance that incorporates our new executive director, and we will transition IAGLR beyond crisis management due to the pandemic toward stability and a sustainable future.

Jérôme Marty to lead association

After a rigorous search resulting in many qualified applicants, we are thrilled to announce Jérôme Marty as our new executive director. Dr. Marty comes to us from his role as a project director at the Council of Canadian Academies, an organization in Ottawa, Ontario, working at the interface between science and policy. Dr. Marty has been involved with IAGLR for the past 10 years, including leadership roles managing the association's annual research conference and serving on the IAGLR Board of Directors, most notably, as president in 2014.

"The search committee was very impressed with Jérôme's depth of knowledge regarding the Great Lakes community with respect to research, policy, and its stakeholders, as well as his extensive not-for-profit experience," says Dr. Trevor Pitcher, chair of the search committee and recent member of the IAGLR Board of Directors. "We are pleased Jérôme will take up the executive director role and work closely with the board, members, and relevant stakeholders to promote and maintain IAGLR's core values and mission."

IAGLR is governed by an all-volunteer board and operated by a two-person staff—a business manager and a communication director, notes IAGLR President Jean Adams. "Adding an executive director to the staff will benefit the association and its members by catalyzing IAGLR's ability to effectively fundraise and strategize. Speaking on behalf of the board, we look forward to working with Jérôme to establish an approach to governance that incorporates this new role."

IAGLR has positioned itself as a strong and unique voice to share about Great Lakes science globally and can act as a knowledge broker for those working in policy making, according to Dr. Marty. "I am excited to work with IAGLR members and the board to expand IAGLR's ability to do so," he says. "Great Lakes science is key to informed decisions for all people living in the basin."

Dr. Marty received his master's degree and Ph.D. in limnology from the University du Québec in Montréal, where he studied zooplankton and carbon cycling. From 2006 to 2012, he was a research scientist at the River Institute, where he worked on invasive species of the St. Lawrence River and the Great Lakes. In 2019, he was appointed to the Science Advisory Board of the International Joint Commission. Dr. Marty recently helped with the creation of the Society of Canadian Aquatic Sciences and volunteers with several organizations working on water in Canada and abroad. He also was chair of the Partnership Group for Science and Engineering. When not working, Dr. Marty can be found canoeing, biking, and playing his favorite instrument, the accordion.

Photo by Piet Verburg

JGLR editors to step down

After 10 years at the helm of the *Journal of Great Lakes Research*, co-editors Bob Hecky and Stephanie Guildford will be stepping down next year. During their tenure, they have tirelessly promoted the journal, traveling to international conferences and facilitating special sections highlighting large lake research outside of North America. The result has been an increase in both international submissions and published articles, an increase in the overall number of journal articles per year, and a higher impact factor that reflects a growing reputation for the JGLR.

"We are grateful to have had Bob and Stephanie helping IAGLR to lead and set the standard for appropriate research and management of large lakes," notes IAGLR Executive Director Jérôme Marty. "Our editors raised the visibility and impact of Great Lakes science worldwide."

The association will be looking for a new editor to start as early as January for a renewable three-year term, although there is some flexibility. We will be posting the job soon. In the meantime, if you have any questions, please contact Jérôme at jmarty@iaglr.org or Publication Committee Chair Jim Bence at pubchair@iaglr.org.

Apply for a scholarship

Each year, IAGLR awards the following scholarships to students showing great promise early in their research careers:

- Norman S. Baldwin Fishery Science Scholarship (two at $3,000)
- David M. Dolan Scholarship ($3,000)
- IAGLR Scholarship ($2,000)

To apply, view the Regulations and Application Procedures for each scholarship linked above. Please note the December 1 deadline.

IAGLR award winners

Congratulations to the following award recipients, who were honored at the virtual IAGLR Awards Ceremony in June. For other award and scholarship winners, please see the Spring 2022 issue, pages 3–4.

Lifetime Achievement Award

J. Val Klump, former dean and a professor emeritus of the School of Freshwater Sciences at UW-Milwaukee. For important and continued contributions to the field of Great Lakes research over a period of 20 years or more.

John R. (Jack) Vallentyne Award

David Dempsey, senior advisor at For Love of Water. For important and sustained efforts to inform and educate the public and policymakers on large lake issues.

Chandler-Misener Award

Erin S. Dunlop, Ontario Ministry of Natural Resources and Forestry, **Mark R. Christie**, Purdue University, **Rob McLaughlin**, University of Guelph, and **Todd B. Steeves**, Fisheries and Oceans Canada. For 2021 most notable paper in the *Journal of Great Lakes Research,* titled "Life history evolution of sea lamprey is predicted to reduce the effectiveness of pesticide control."

Elsevier Early Career Scientist Award

Jasmine Mancuso, Oakland University. For 2021 most notable paper in the *Journal of Great Lakes Research,* titled "Cold and wet: Diatoms dominate the phytoplankton community during a year of anomalous weather in a Great Lakes estuary."

Elsevier Student Author Award

Taylor Stewart, Mississippi State University. For 2021 most notable paper in the *Journal of Great Lakes Research,* titled "Shining a light on Laurentian Great Lakes cisco (*Coregonus artedi*): How ice coverage may impact embryonic development."

KUDOS

Congratulations to the following IAGLR members for their accomplishments!

EVIE S. BRAHMSTEDT will begin a postdoctoral fellowship at the New York State Water Resources Institute at Cornell University.

CATHERINE FRIDOLIN finished her master's coursework at the University of Dar es Salaam (Tanzania).

JESSICA IVES started a new position as special projects coordinator with the Great Lakes Fishery Commission.

JOHN JOHNSTON (University of Waterloo) received the 2022 Jane Lang Excellence in Earth and Environmental Sciences Teaching Award, which acknowledges instructors who demonstrate a dedication and enthusiasm for high quality teaching and inspire undergraduate and graduate students to appreciate and understand the natural world. In addition, Johnston was recently featured on the Weather Network segment "From soft sand to rocky shores, discover Ontario's beach diversity."

MICHAEL JONES retired from Michigan State University, where he co-founded the Quantitative Fisheries Center and, since 2014, was the Peter A. Larkin Professor of Quantitative Fisheries. An IAGLR member since 1992, Jones served as IAGLR president in 1999.

TASSIANE JUNQUEIRA (Queen's University) received a Seed Funding Award for Globally-Engaged Research Collaborations for research titled "Applying Cu and Zn isotopes as an environmental tool to trace sources and fates of metals in the Laurentian Great Lakes." This award supports Junqueira's going to L'Institut Français de Recherche pour l'Exploration de la Mer (IFREMER; the French Research Institute for Exploration of the Sea) to work with experts there and to visit the GET-CNRS facilities.

MARGARET LANSING retired from the NOAA Great Lakes Environmental Research Laboratory (GLERL), where she worked for 35 years, most recently as chief of information services in charge of science communications and public affairs. For this work, she received IAGLR's 2021 John (Jack) R. Vallentyne Award. Lansing began her career with GLERL doing field work and bench chemistry. In 1989 she received the IAGLR Mott Fellowship and was runner-up for the IAGLR Hydrolab Best Student Presentation Award at the annual Conference on Great Lakes Research. She has been a career-long member of IAGLR and says "participating in IAGLR meetings was one of the biggest influences on my Great Lakes career. I am making it a point to give back to IAGLR and hope other fellowship recipients will consider doing the same when they are in a position to do so."

DEBORAH LEE (NOAA GLERL Director) has been awarded the 2022 American Society of Civil Engineers President's Medal for "her leadership of the Environmental and Water Resources Institute to provide for the technical, educational, and professional needs of its members, and to serve the public in the use, conservation, and protection of natural resources, and enhancement of human well-being."

NEW MEMBER SPOTLIGHT

Meet five of our new members who have recently joined IAGLR.

Simon Freeman

Senior in Fisheries Management, Student Research Technician, Lake Superior State University, Center for Freshwater Research and Education

About my work

Throughout my time at Lake Superior State University I received a hands-on education while in class and working several research technician positions with the Center for Freshwater Research and Education (CFRE). In 2021 I worked in our Atlantic salmon fish hatchery, surveyed for freshwater mussels, and began my senior thesis. Now in the summer of 2022, I sampled for larval lake whitefish and cisco and zooplankton in Lake Huron. Additionally, I took part in a setline survey for lake sturgeon, and sampled for CFRE's European frog-bit project. I am very thankful for these opportunities as an undergraduate student!

Favorite part of work

I conducted my undergraduate research thesis on day versus night relations between larval lake whitefish and zooplankton in lakes Michigan, Huron, and Superior. From the field, lab, and data work, to presenting and writing, this project has provided invaluable training and professional development. Thank you to my mentors at LSSU CFRE and beyond for this Great Lakes research experience!

Something else about myself

My goal has always been to stay and work in the Great Lakes region. I grew up fishing primarily in Lake Huron. I was always asking *how, what*, and *why* while on the water. Now, as I reflect on my time as an undergraduate, asking those same questions while conducting important research on the Great Lakes, I can say that there is no better time to have that goal in mind.

Richard Micka

International Wildlife Refuge Alliance

About my work

As a volunteer for the International Wildlife Refuge Alliance, it has been a rewarding experience to work with other community leaders as a friends organization for the Detroit River International Wildlife Refuge operated by the U.S. Fish and Wildlife Service in Southeast Michigan. The late Congressman John D. Dingell Jr. was responsible for the creation of this refuge in 2001.

Favorite part of work

As chair for the International Wildlife Refuge Alliance Board of Directors the last 14 years, I have come to appreciate the generosity of the people in the Downriver (Detroit) community. They are gracious and appreciate the opportunity to be part of an outdoor experience in their backyard. Many had never had the opportunity to see this part of the Detroit River.

Something else about myself

Be sure to visit the Refuge Gateway in Trenton, Michigan. You will experience what I have as you meet the U.S. Fish and Wildlife Service staff and volunteers who greet everyone with a kind word and friendly smile carrying on the tradition set by Congressman Dingell, who was a champion of all wild things on both sides of the Detroit River.

Rebecca Nixon

University of Delaware

About my work

As an environmental social scientist, my research focuses on the social dimensions of climate change, environmental justice, and coastal community resilience. I am currently working on a project with Illinois-Indiana Sea Grant focused on revitalization in Great Lakes Areas of Concern. I also get to work with and teach an outstanding group of undergraduate and graduate students at the University of Delaware.

Favorite part of work

One of my favorite parts of my work is the opportunity to collaborate with community partners and work in interdisciplinary projects. I really value learning from and working alongside a diverse team, and it is exciting to see the innovative research and outreach that comes from deep collaboration.

Something else about myself

I was born and raised in Detroit, Michigan, and fell in love with the outdoors through summer days on Lake Michigan and backpacking trips to the Upper Peninsula. I am incredibly grateful I get to continue to be connected to the Great Lakes through my work.

NEW MEMBER SPOTLIGHT

Charity Nonkes

University of Ottawa; Sea Lamprey Research & Management–Indigenous Input & Inclusion Project

About my work

In partnership with the Saugeen Ojibway Nation (SON), we conducted a study on the opportunities and challenges of engaging Indigenous communities and bridging knowledge systems (e.g., Indigenous Knowledge and Western science) in sea lamprey management. We did this through a case study of Denny's Dam, which is a sea lamprey control barrier within SON Territory that needed to be rehabilitated. The rehabilitation started from a place of conflict and delay, but became possible after knowledge coexistence, respect, and partnership between SON and the Great Lakes Fishery Commission was established.

Favorite part of work

The best part has been collaborating with the SON and learning about the power and importance of knowledge coexistence and Two-Eyed Seeing in environmental stewardship!

Something else about myself

As someone who is non-Indigenous, I think it is very important to learn about and build relationships with the Indigenous groups whose Territory your research is taking place on. By doing this in a good way, you can bridge knowledge systems and create a more robust and complete picture of your research. This has been a game changer for me, and I hope to carry this into my career once I graduate.

Sovannara Uk

Recent graduate of Department of Civil and Environmental Engineering, Tokyo Institute of Technology, Japan

About my work

I have recently graduated from the Tokyo Institute of Technology, Japan, where I did a research study on phosphorus dynamics and its role in primary production in a tropical shallow lake with a monotonal flood pulse. Tonle Sap Lake in Cambodia, which is the largest freshwater lake in South East Asia, is the study area of my research. This lake is a large and complex data-deficient ecosystem in which there exist many interactions among various components, while our understanding of this ecosystem is fragmented and immature.

Favorite part of work

The most interesting part of my work is that I have a chance to be involved in an international project where I could collaboratively work with other researchers from different countries and fields of study. I've also come to realize that transdisciplinary research collaboration in the broad fields of study is essential to address the complex environmental issues facing freshwater lakes globally.

Something else about myself

To me, to be able to make a contribution to society and scientific communities through my research studies is meaningful. I am excited to meet other members of IAGLR and sincerely hope that my participation in IAGLR will allow us to collaboratively work to make an impacts on the world.

Welcome new members who joined May–July 2022

Donnata Alupot
Joshua Benjamin
Gladys Chigamba
Ruth Duncan
Marie Claire Dusabe
Simon Freeman
Catherine Fridolin
Ruby Ghosh
Kyle Glenn
Clare Helmer
Maria Hernandez Limon
Esther Kagoya
Michelle McCrackin
Justin Meyer
Lizy Michaelson
Richard Micka
Grite Mwaijengo
Christine Mwirigi
Mary Nantongo
Charity Nonkes
Rajendra Poudel
Daniel Sandborg
Margret Sinda
Sovannara Uk
Diane Umutoni
Catherine Wachira
Kira Yerofeev

THE NEARSHORE

A legacy of modifications and heightened impacts and also a source of hope

by Scott Colborne

Nearshore areas of the Great Lakes are far more than just beaches for us to enjoy some swimming time during the summer months. Nearshore habitats vary greatly from beach shorelines and rock ledges to bays and marshes to connecting channels between the lakes. These varied nearshore habitats represent fundamental components of the health and productivity of the entire Great Lakes region.

Modifications of nearshore habitats are not unique to the Great Lakes, but they are widespread and many have been largely forgotten over time. For example, most of Grant Park in Chicago used to be part of Lake Michigan before fill was used to move out the shoreline, but most people today would assume the park has always been a part of the city. Early 20th century engineering dammed sections of the Detroit River to facilitate shipping channel construction. Historical pictures such as the one shown at right are worth viewing and drive home the extent of the modifications that lie below the surface to this day (Bennion and Manny 2011). All of these engineering marvels undoubtedly helped build the cities and economic engine of the Great Lakes region. However, these activities also contributed to the loss of habitat for spawning and juvenile nursery habitats and in recent years brought about efforts to restore habitat and reconcile the needs of humans with the wildlife of the lakes. Fortunately, many native fishes appear to respond well to these habitat restoration efforts (e.g., McLean et al. 2015), and we continue to refine these efforts (e.g., Fischer et al. 2020).

We cannot discuss impacts on nearshore habitats without also considering invasive species—even though invasive species are usually discussed in terms of changes to the pelagic habitats of the Great Lakes, often with a focus on salmonids and alewife. However, many invasive species, such as dreissenid mussels and round goby, are also prevalent in nearshore habitats. Round goby in particular have been documented as egg predators, potentially adding to the burden of parental care for nesting fishes (e.g., LeBlanc et al. 2020) and impacting overall reproductive success for many species. On the other hand, round goby can consume dreissenid mussels, potentially releasing the energy collected from the water column by the mussels back into the food web. Indeed, reports of largemouth and smallmouth bass indicate that these nearshore species may be benefiting from round goby by having a new abundant prey source to consume (e.g., Crane and Einhouse 2016). Furthermore, the Lake Erie watersnake population is rebounding, in part due to consuming large quantities of round goby (e.g., Jones et al. 2009). Overall, invasive species are a complicated issue, and I am not advocating that these species are helping the lakes. They undoubtedly pose serious challenges to ecological relationships and overall stability of the region. However, for many of the established invasive species, the reality is that they are going to be present long-term. We are still striving to understand how they fit into the Great Lakes ecosystem, predict how they could impact future conditions, and respond as best as possible to help manage

The Detroit River's dewatered Livingstone Channel features formidable bedrock and limestone formations in this 1933 photo. Between 1907 and 1912, a massive widening and deepening project took place in the 12-mile channel. Coffer dams were built to hold back the water, and dynamite was used to blast out bedrock and limestone. Additional deepening and widening projects occured in the 1920s and '30s. Photo credit: U.S. Army Corps of Engineers.

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the system for long-term productivity. As the success of sea lamprey control efforts have demonstrated, just because invasive species pose a major challenge doesn't mean we don't have a capacity to respond and make things significantly better.

In addition to responding to invasive species already present, substantial efforts are also underway to limit the possibility of future invasion events into nearshore habitats. Bighead and Silver carp are two potential invasive species of major concern to the Great Lakes. Grass carp have already been detected in the nearshore areas of Lake Erie, but efforts are underway to respond to these fish while the population size is relatively small (e.g., Robinson et al. 2021). We just have to look at their impact in the Mississippi River system to know that this is a serious threat to the Great Lakes, and it is the nearshore habitats most at threat by these potential invaders. To protect the Great Lakes we need to continue monitoring nearshore habitats, such as the eDNA sampling conducted by the U.S. Fish and Wildlife Service.

Finally, nearshore habitats are the regions in which people have the greatest interaction with the Great Lakes. The designation of Areas of Concern (AOCs) in the Great Lakes has focused on nearshore habitats, including the Detroit River. The AOCs have undergone remarkable management and restoration efforts (see the cover article in the Summer 2019 *Lakes Letter* by John Hartig), with some areas being delisted due to the improvements. I've had the pleasure of being involved with multiple research projects involving nearshore habitats, including the former dumping grounds at Fighting Island on the Detroit River, pictured below. I am continuously struck by the natural beauty of these nearshore areas, the efforts to help improve the habitat, and the passion of local communities for the lakes. We increasingly recognize the serious threats faced by freshwater ecosystems, (e.g., see the cover article in the Spring 2022 *Lakes Letter* by Steven Cooke), but the nearshore habitats of the Laurentian Great Lakes are also a source of hope for freshwater ecosystems. Are there challenges and concerns for the future? Absolutely. However, there is community engagement, broad political support, and world-class management and research happening throughout the Great Lakes region. So the next time you head to the shoreline, take a few minutes to look around you and appreciate these complex and vital nearshore regions of the Great Lakes and ask yourself how you can help keep the lakes vibrant for future generations to enjoy.

Round goby collected from the Detroit River (2022). Photo by Scott Colborne.

> "We increasingly recognize the serious threats faced by freshwater ecosystems, but the nearshore habitats of the Laurentian Great Lakes are also a source of hope for freshwater ecosystems."

Scott Colborne is a postdoctoral researcher at the University of California, Davis, Department of Wildlife, Fish, and Conservation Biology.

Fighting Island shoreline in the Detroit River (2022). Photo by Scott Colborne.

Great Lakes Estuaries

Hot spots of productivity, problems, and potential

by Tony Weinke, Ian Stone, Jillian Greene, Sean Woznicki, Janie Cook,
Nate Dugener, and Bopi Biddanda

Author Tony Weinke returns from a maintenance run to the Muskegon Lake Observatory buoy, which gathers weather and water quality time-series data on the urbanized, mesotrophic lake. A model drowned river mouth estuarine ecosystem, Muskegon Lake is on track to being delisted as a Great Lakes Area of Concern, yet the lake's 2011–2022 observatory data on harmful algal blooms and hypoxia indicate ongoing impairments.

All rivers terminate in a lake or sea, with their meeting place known as an *estuary*. Rivers joining freshwater lakes form freshwater estuaries, and a common type found in the Laurentian Great Lakes is the drowned river mouth estuary (DRM). These estuaries came to be as the Earth's crust rebounded following glacier retreat, forming lakes at the ends of watersheds that then flow out into the Great Lakes. Such DRMs are often buttressed by coastal dunes that cause further flooding and produce secondary DRMs of their own.

Today, there are more than 100 DRMs in the Great Lakes basin, with the densest assembly, over two dozen, found along the eastern shoreline of Lake Michigan. These DRMs share many common hydrogeologic characteristics, but vary widely in terms of size, depth, productivity, water quality, shoreline development, land use, and vegetation. These similarities and differences present opportunities for understanding the estuaries' role in the social, economic, and ecological context of the Great Lakes basin. For example, these estuarine ecosystems provide crucial wetland habitats that create havens for native fish and wildlife, and they are also prime areas of commerce and recreation.

Goldilocks zones of watershed productivity

DRMs are critically important Great Lakes ecosystems that foster ideal conditions for the formation of wetlands, enhanced primary production, and fisheries in the Great Lakes basin. The slowing of the river in a DRM allows for deeper sunlight penetration into nutrient-rich waters, promoting the growth of algae at the base of the food

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web and making these estuaries *Goldilocks* zones of optimal productivity in the watershed. Enhanced primary productivity in conjunction with extensive and diverse wetlands provides the food and spawning habitat to support rich fisheries. High productivity and calm waters relative to adjacent water bodies also create optimal zones for trapping carbon and other nutrients in sediment, making them effective nutrient and carbon sinks in the watershed.

Hot spots of human activity

The sheltered DRMs also create protected shipping ports for industry and housing. Since the 1800s, industries enabled by these estuaries, such as foundries and logging, have supported several large coastal communities, including Charlevoix, Holland, Ludington, Manistee, and Muskegon. The latter was once the lumber capital of the world and played a crucial role in rebuilding Chicago after the Great Fire in 1871.

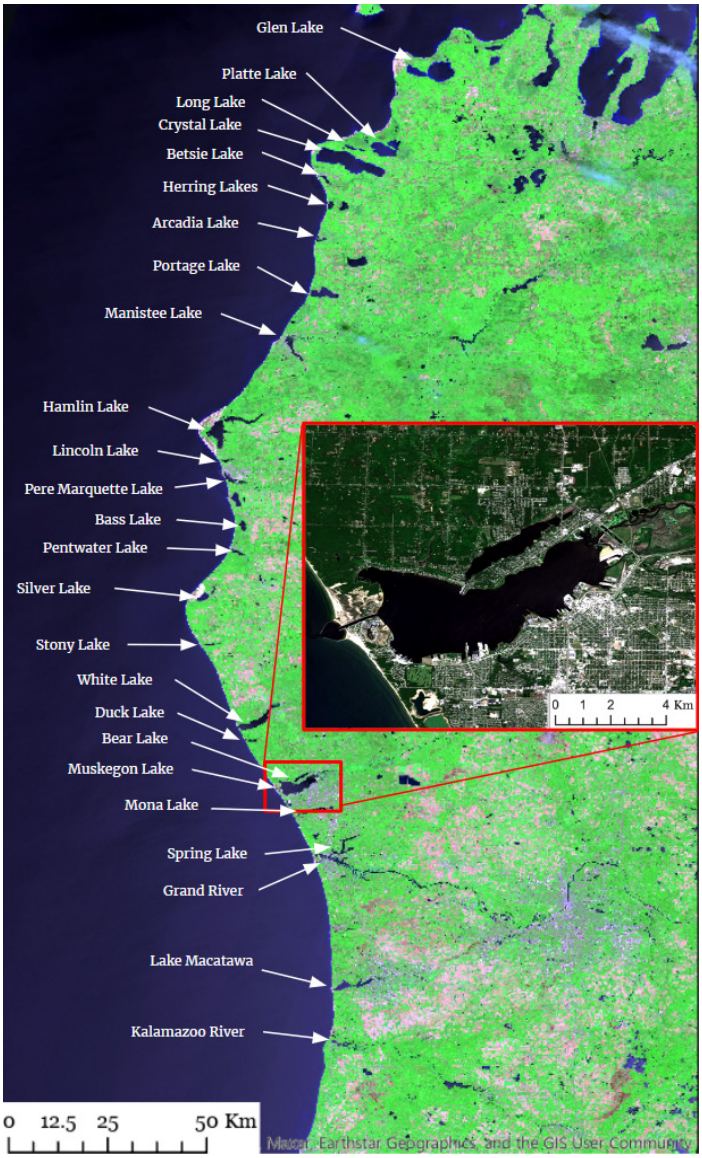
Urbanization and agricultural expansion make DRMs hot spots of anthropogenic problems such as harmful algal blooms, sediment contamination, shoreline hardening, bottom water hypoxia, and habitat loss. Currently, about half of the DRMs along the western coast of Michigan experience annual harmful algal blooms and hypoxic conditions. Additionally, once these troubled waters leave the estuaries into the Great Lakes proper, they have the potential to affect drinking water intakes or cause beach closings. Indeed, almost every Great Lakes Area of Concern site is in an estuary.

The impact of humans on DRMs varies along a latitudinal gradient with northern systems being relatively shielded. For example, west Michigan's southern watersheds have intensive conventional row-crop agriculture and more populous towns relative to northern watersheds.

Rich sites for research

Given DRMs' distribution along a gradient from natural (e.g., more forested to the north) to anthropogenic (e.g., more urbanized to the south), these estuaries provide ideal conditions for an ongoing real-time experiment. In addition, DRMs integrate changes occurring within their watershed due to their terminal location within the system. Global and regional changes are signaled early in highly responsive DRMs dispersed throughout the Great Lakes basin. As such, studying these estuaries can provide insights not only into the sensitive DRMs themselves, but into the health of entire watersheds. While

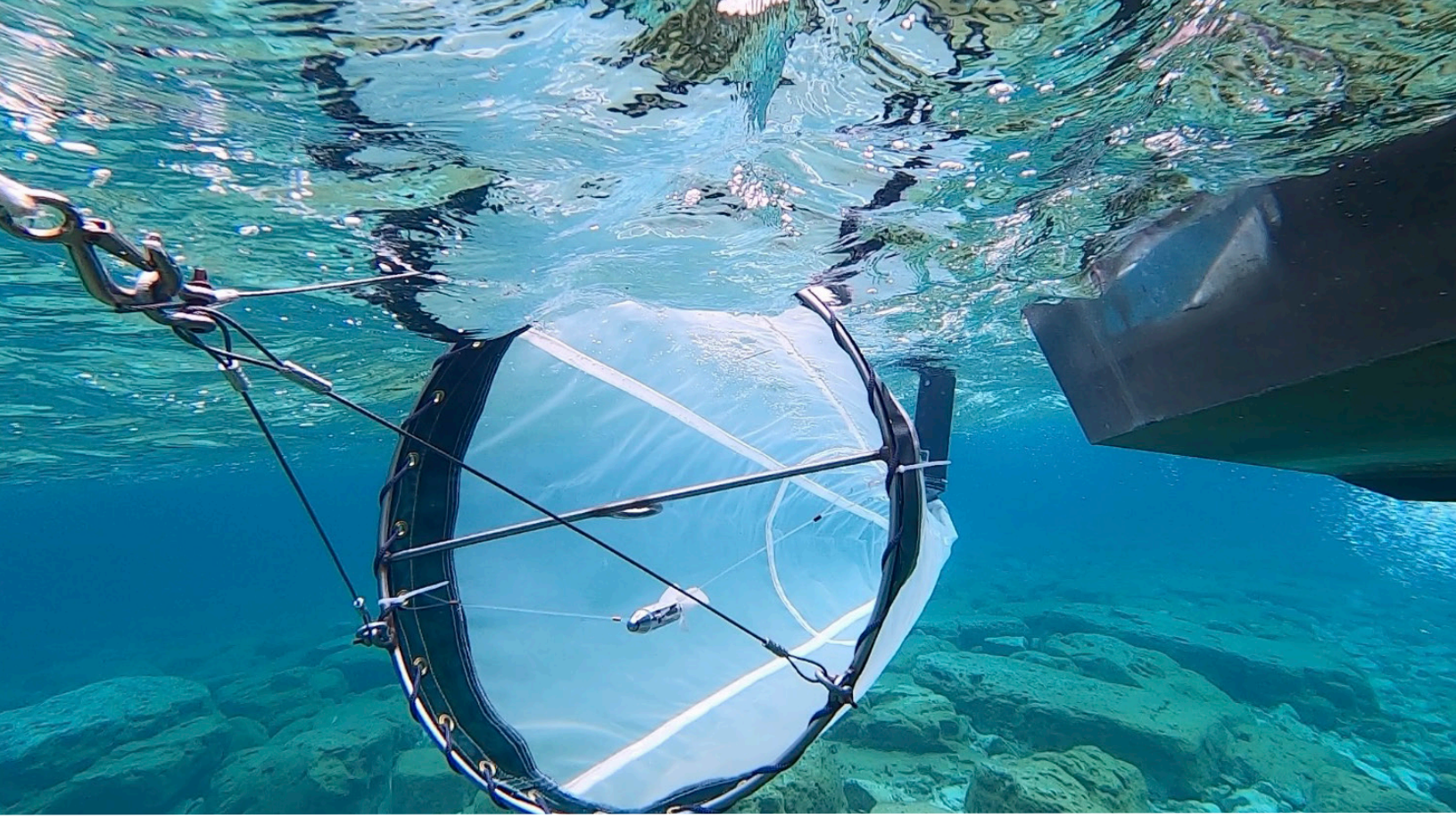
> "Global and regional changes are signaled early in highly responsive DRMs."



Satellite view of an array of DRMs along the eastern coast of Lake Michigan in the false color Landsat-8 imagery (courtesy of the U.S. Geological Survey, west Michigan, June 18, 2022). Inset: close-up of the urbanized Muskegon Lake in the Sentinel-2 satellite imagery (courtesy of Copernicus Open Access Hub, Muskegon Lake, June 16, 2022). Impact of urbanization and other anthropogenic land use changes on the watersheds can be seen in pink, decreasing along a south-north latitudinal gradient.

knowledge of DRMs has progressed dramatically in recent years, and great strides have been made to restore degraded estuaries, they remain hot spots of anthropogenic use. Multiple stressors such as pollution, land use change, and climate change continue to pose a threat. Although challenges loom, DRMs carry tremendous ecological, social, and economic potential worthy of our understanding and protection. Therefore, we propose that this unique brood of DRMs found along Lake Michigan's eastern shoreline be designated as a National Estuarine Research Reserve.

Tony Weinke, Ian Stone, Jillian Greene, Sean Woznicki, Janie Cook, Nate Dugener, and Bopi Biddanda, Annis Water Resources Institute, Grand Valley State University, Michigan.



Deployed larval fish sampling net being towed alongside the boat within Lake Huron. All photos courtesy of CWMP.

Saugeen Ojibway Nation's Coastal Waters Monitoring Program

by Emily Mansur and Kathleen Ryan

WITH A TERRITORY surrounded by three parts Water comes huge responsibility. The Saugeen Ojibway Nation (SON) describes the shared Territory of the Chippewas of Nawash Unceded First Nation and Chippewas of Saugeen First Nation, our People, our Lands, Waters, our Ancestors, and our non-human relatives. SON covers over 2 million acres of land and includes the lakebed to the halfway mark of both Lake Huron and Georgian Bay.

SON relates to the Water as a sacred and living entity. Since time immemorial, SON members have relied on the Water for sustenance and livelihood, while caring for and protecting it through stewardship and ceremony. We have an undeniable and sacred relationship with the Water. Our relationship and responsibility is not only with the Water, but also with the diversity of life that the Water supports.

Stressors impacting Lake Huron and Georgian Bay continue to rise, as do SON members' concerns. Nuclear energy production and storage, shoreline development, alterations and hardening, constant anthropogenic influence, and the stocking of non-native fish species are just a few stressors that both individually and cumulatively could impact not only SON's relationship with the Water but also SON's court-proven rights to the fishery (*R. v. Jones and Nadjiwon, 1993*).

As caretakers of these Lands and Waters, SON felt it was essential to be a key part of the design and implementation of programs that assess and monitor the interactions and impacts related to stressors and the health and ecology of our Waters. The Coastal Waters Monitoring Program (CWMP), part of the Environment Office of the Saugeen Ojibway Nation, is a community-based, long-term environmental monitoring program with the goal of understanding (monitoring, assessing, connecting with), and protecting the nearshore aquatic environments of SON Territory. Coastal regions are used by nearly every fish at some point in their life cycle. These habitats provide essential structure, food, and protection for not only fish but for many other types of wildlife.

Knowledge and information gathered from CWMP will form the basis of how we understand the current conditions and health of coastal habitats and wildlife (especially fish) across the Territory. Fish community, Water quality, aquatic vegetation assessments, temperature monitoring, and other assessments will provide us with the opportunity to understand our Territory in

continued

a meaningful way, to identify changes and stressors, and to take meaningful action to rehabilitate and restore habitats and species and mitigate or eliminate the stressor(s).

Since 2019, the CWMP has collected the largest multi-year dataset on nearshore fish and fish habitat compared to that of any other agency in the SON territory. To date, the team has sampled nearly half a million fish, identifying more than 60 different species. Aside from the importance of collecting data, the program is crucial for the simple action of being with the Land and in the Waters every day. To see. To touch. To learn. To remember. We are consistently expanding our collective ecological knowledge, our connection to the environment of our Territory, and the way that we relate to and understand the nearshore habitats.

The interactions and relationships we have with these living beings, with the Water, and with the Land are extremely meaningful. Isn't it special how we are all so different, yet rely on the same habitats to keep us alive?

It's not too late to get one's feet wet and strive to make a difference for our Water. Let us ask you, what role do you play in your relationship with the Land, Water, and non-human relatives? What will you do to protect and preserve the Waters and our non-human relatives after all they have given to us?

Emily Mansur, CWMP acting manager, and Kathleen Ryan, program creator and acting consultant, Environment Office of the Saugeen Ojibway Nation.

At right, from top: CWMP Acting Manager Emily Mansur (left) and Elisha Jones (right). Painted Turtle, the most common turtle species found and assessed by CWMP. Beautiful colour variation shown in the Centrarchids.

Below: Staff pulling a seine net to capture fishes using the shoreline during the time of assessment. This is typically done in areas where setting a fyke net is not feasible.

View of interdunal wetland in 2019 (left) and 2022 (right) after water levels in nearby Lake Michigan dropped.

Ecohydrology of a Lake Michigan interdunal wetland

by Suzanne DeVries-Zimmerman

NESTLED within the Great Lakes coastal dunes lie interdunal wetlands or slacks, imperiled ecosystems with high biodiversity. The Hope College Coastal Group has been conducting an ecohydrological study in one such interdunal wetland in the Saugatuck Harbor Natural Area (SHNA) south of the Kalamazoo River mouth near Saugatuck, Michigan since 2016. Our work includes annual vegetation quadrat sampling, remote sensing flights with an unoccupied aerial vehicle (drone), and sampling of groundwater and surface water within and around the wetlands. Wetlands were absent from this area prior to 2014 due to the low Lake Michigan-Huron lake levels. The area was generally dry with dominant upland/dune vegetation except for several ponds along the northernmost wetland edge. However, rising lake levels, beginning in 2014, wetted the area, allowing wetland vegetation to germinate from the seedbank.

Our initial work focused on how water levels within the wetland influenced the diversity, density, and distribution of vegetation. As the wetland has a subtle microtopography, we established over 40 vegetation quadrats that are surveyed annually. We noted that vegetation was zoned according to water depth, and that the highest diversity was found along the damp edges of the wetland. Additionally, in 2016 and 2017, damp ground to shallow water (about 16 centimeters deep) supported dense stands of *Cladium mariscoides* with accompanying *Spiraea tomentosa*, especially in the central portion of the wetlands. *Carex* and *Juncus* species dominated the deeper ponds along the northern edge. As lake levels continued to rise between 2018 and 2020, water in the central ponds deepened to more than 70 centimeters, significantly decreasing the overall vegetation density and creating large areas of open water. The areal extent of the wetlands increased, however, as rising water submerged new areas, allowing wetland vegetation to germinate from the seedbank there.

Water levels decreased significantly, about 0.5 meter, from 2020 to 2021. Hence, we hypothesized that vegetation density would increase again in response. However, we failed to fully account for the activities of muskrats (*Ondatra zibethicus*) on the vegetation stands. In winter 2019–2020, muskrats migrated from a nearby water body to our study area, burrowing under the banks, eating selected vegetation types during summer 2020, creating lodges of vegetation in fall 2020, and most significant of all, foraging for seeds, rhizomes, and roots in the sediments under the ice in winter 2020–2021. Consequently, when water levels dropped, there was little to no vegetation in the central portion of the wetland in summer 2021. In 2022, water levels further dropped about 0.2 meter. The wetlands' edges and areas marginally impacted by the muskrats have dense stands of *Cladium mariscoides* as anticipated. However, little to no growth of vegetation has been noted in the central portion of the wetlands thus far. It remains open water and mud flats with muskrat channels still visible in the sediments. Hence, we are now documenting how vegetation re-establishes following a major disturbance, in this case, a muskrat "eat-out," in addition to monitoring vegetation changes in response to changing water levels.

Same wetland in 2022 with mud flat resulting from low water levels and the arrival of muskrats.

Suzanne DeVries-Zimmerman is an assistant professor of instruction in the geological and environmental sciences department at Hope College.

Great Lakes Coastal Wetlands

by Titus Seilheimer

All photos by Titus Seilheimer unless otherwise noted.

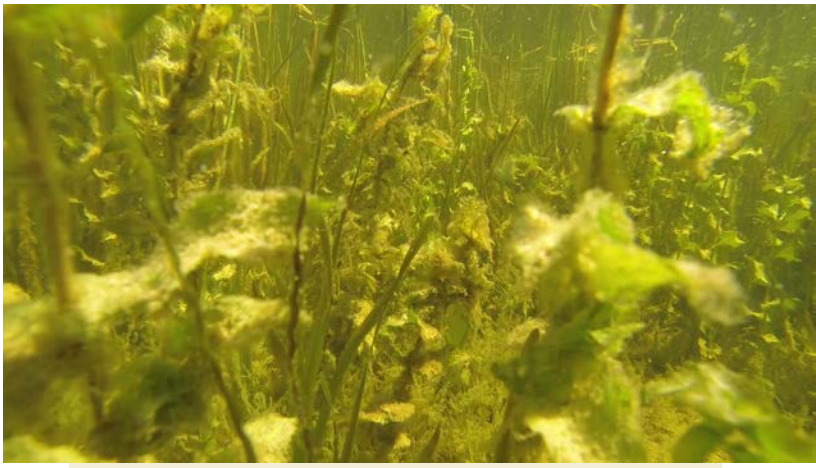
WHERE THE LAND MEETS THE WATER of the Great Lakes is one of the most magical places in the world, especially when it comes to coastal wetlands. These marshes fringe the bays, inlets, and river mouths in all five lakes, from the rocky shores of Lake Superior to the barrier beaches of Lake Erie. Coastal wetlands contain a complex mix of plants and animals and serve as vital spawning and nursery habitat for many species of fish, as well as other animals. Because the wetlands are shallow, warm, and productive, they are an ideal place to hatch and rapidly grow. Nearly three quarters of all fish species in the Great Lakes are estimated to rely on coastal wetlands for some part of their life or their food source's life (Jude and Pappas 1992). Wetland habitat has been lost or degraded over the years, especially in populated areas, but even the most degraded sites are still home to a surprising diversity of fish species. Words do not convey the magic of coastal wetlands, so the story is told here through images.

A DYNAMIC LANDSCAPE

The landscape of coastal wetlands is very dynamic, from the true uplands to the deeps of the Great Lakes. These dynamic habitats warm rapidly in the spring, can absorb nutrients and sediment, and can help buffer flooding. Coastal wetlands are influenced by the rise and fall of water levels in the Great Lakes, but they can move up and down with those changes.

VEGETATION

Three important zones of vegetation are the emergent, floating, and submerged. Emergent vegetation commonly encountered are cattails (*Typha* sp. - native, invasive, or hybrid), invasive Phragmites, and bulrush (*Schoenoplectus* sp.). Floating vegetation are often water lilies (white and yellow) that add color to the wetlands. Submergent vegetation can be very diverse, with many species of pondweed (*Potamogeton* sp.), wild celery, and common waterweed.



A PEEK BELOW

Taking the plunge to view wetland habitat underwater shows a great deal of complexity in the height and structure of the aquatic plants. The plants provide surface for attached algae to grown on, habitat for invertebrates, and hiding and foraging places for fish of many sizes. The Mink River Estuary in Wisconsin, pictured here, is a great place to explore.

RESIDENT FISH

Some fish species are wetland residents and spend most of their time there. Many of these species have a lower profile than the sport and commercial species. Bowfin (below) and central mudminnow are two species commonly found in coastal wetlands. Sunfish, bullheads, and minnows are also important parts of the wetland fish assemblage.

VISITING FISH

Great Lakes coastal wetlands serve as spawning and nursery habitat for many fish species, like the northern pike, largemouth bass, and yellow perch (above). The juvenile fish species may move out of the wetland into the larger lake when they reach a large enough size.

Photo by Amy Carrozzino-Lyon.

BIODIVERSITY

In addition to fishes, there are many other groups of animals that reside in coast wetlands, such as birds, mammals, reptiles, and amphibians. Some are residents and some use the habitats for feeding or nesting. At left, the author is shown with a grumpy snapping turtle in Seagull Bar wetland, Marinette, Wisconsin.

Degraded sites can be home to a surprising diversity of species. The marsh in the Little Manitowoc River shown below has degraded water quality with few submerged aquatic plants, but has 25 fish species, including juvenile northern pike and largemouth bass.

Titus Seilheimer is a fisheries specialist at University of Wisconsin Sea Grant Institute

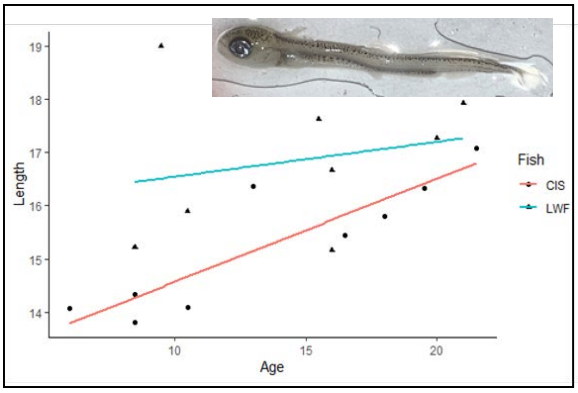
Diet and growth of larval coregonines in the nearshore waters of Lake Michigan-Huron

Great Lakes nearshore zones, often defined as areas less than 10 meters deep, play a crucial role in the life history of many native fishes, as they provide nursery habitat for newly hatched fish. Nearshore areas are greatly affected by anthropogenic stressors such as sedimentation, nutrient addition, pollution, and climate change. Despite the importance of nearshore zones to native Great Lakes fishes, very little is known about ecology in this region.

Coregonus species lake whitefish (*Coregonus clupeaformis*) and cisco (*C. artedi*) rely heavily on these nearshore areas during several periods of their life history, including spawning, egg incubation, and larval development. Populations of lake whitefish and cisco have fluctuated dramatically throughout the upper Great Lakes since the early 1900s due to overfishing, predation, and changing environment. Since 2011, cisco have resurged in northern Lake Michigan, whereas lake whitefish have declined. Causes of differential recruitment, likely at early life stages, are not known but may include reduced nearshore zooplankton abundance following the dreissenid mussel invasion.

To determine if low food differentially affects young lake whitefish and cisco, I examined gut contents and growth of larval coregonines in relation to prey availability. I hypothesized that larval cisco would have higher prey intake at low prey densities, leading to growth rates surpassing those of larval Lake Whitefish. Tribal and state agencies collected larval fish and zooplankton samples at nearshore sites in 2019 and 2021. Ages were determined via otolith daily growth rings and lengths via imaging software. Zooplankton were enumerated and larval fish identified to species genetically.

Prey densities were exceptionally low in nearshore waters. Larval growth rates were positively associated with prey density and availability of midge larvae.



Larval Lake Whitefish (n = 8) and Cisco (n = 9) growth from a northern Lake Huron site. Larval Cisco were smaller in size but grew more rapidly than larval Lake Whitefish at this site in 2019.

Larval cisco consumed smaller prey items than larval lake whitefish. Larval cisco started out smaller than larval lake whitefish but grew faster (see figure). Fast larval growth amidst low prey availability could give cisco an advantage over lake whitefish in the northern Lake Michigan-Huron region.

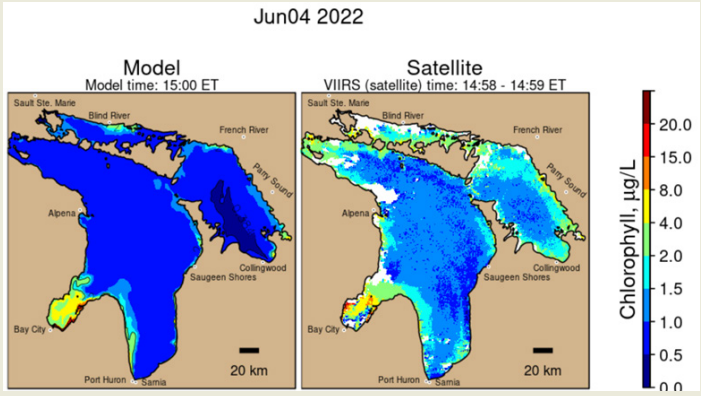
By Kelly Hoyer, Central Michigan University.

An Experimental Biophysical Nowcast-Forecast System for Lakes Michigan and Huron

Declining offshore productivity in lakes Michigan and Huron has been a multi-decadal trend causing scientists to investigate the importance of nearshore primary productivity in supporting the lakes' fisheries. However, the dynamic nature of the nearshore environment in the Great Lakes makes studying these areas inherently challenging. Shifting currents, variable tributary nutrient inputs and flows, and coastal upwelling/downwelling effect a dynamic and patchy pattern of primary productivity "hot spots" in the nearshore that can be difficult for field researchers to locate and sample.

The Cooperative Science and Monitoring Initiative (CSMI) is a binational effort to coordinate research priorities and monitoring activities on one of the five Great Lakes each year. Research priorities guiding the CSMIs for Lake Michigan (2020) and Lake Huron (2022) included studying the importance of tributaries and nearshore areas to lake productivity and the need to focus sampling efforts on these productivity hot spots. The NOAA Great Lakes Environmental Research Laboratory and Cooperative Institute for Great Lakes Research, with funding from the U.S. Environmental Protection Agency, developed an Experimental Biophysical Nowcast-Forecast System for Lakes Michigan and Huron.

The experimental forecast system simulates lake hydrodynamics and the influence of runoff and phosphorus inputs from 124 tributaries on spatial patterns of chlorophyll-a concentration and dissolved organic carbon (DOC). Chlorophyll-a and DOC are displayed as indicators of the influence of rivers on primary productivity and as a tracer of river water as it disperses into the lake,



A comparison of model to independent satellite observations of Lake Huron chlorophyll concentrations from June 4, 2022. Transport of productive waters from Saginaw Bay near Bay City (highlighted in brighter colors) down to Port Huron, Michigan, is a common spatial pattern that emerged in the model and was confirmed by satellite imagery.

respectively. The same two variables are compared side by side to recent satellite imagery obtained from the Great Lakes CoastWatch node. In addition, the archived model and satellite imagery from past dates provide context to observations, and inform planning of future surveys. Use of biophysical nowcast-forecasts and recent satellite imagery to support field research may lead to new insights on transient features, such as river plumes and productivity hot spots, in dynamic nearshore areas. *Learn more about the physical model and development of the biophysical model.*

By Mark Rowe, NOAA GLERL, and Peter Alsip and Aubrey Lashaway, CIGLR.

Wisconsin climate change report showcases impacts and solutions for coastal communities

The Wisconsin Initiative on Climate Change Impacts (WICCI) released its latest assessment of climate change in Wisconsin earlier this year with information and tools to make Great Lakes coastal communities more climate resilient. The report shows that warming temperatures and changing precipitation patterns are impacting the state's coastal ecology and communities. The last two decades have been the warmest on record in Wisconsin, and the past decade has been the wettest.

In the report, a focus on climate impacts to Great Lakes ecology shows Great Lakes water level fluctuations and changes to water temperature, lake mixing, and ice cover are impacting Great Lakes water quality and habitats. For example, the increasing frequency of extreme precipitation events and warming waters are impacting the amount and cycling of nutrients and contaminants in the nearshore lake environment, leading to more microbial contamination on beaches and increasing the risk of potentially toxic blue-green algal blooms. A focus on climate impacts to Wisconsin's Great Lakes coastal communities shows that large fluctuations in Great Lakes water levels along with flooding and bluff erosion from extreme storms are impacting the areas along the state's coastlines and causing uncertainty for coastal communities and industries. Wave energy reaching Great Lakes coasts is expected to increase in the future, in part due to anticipated decreases in ice cover extent and duration.

Danger Thin Ice, 2015 Great Lakes Photo Contest natural category, by Edward Deiro.

By Dea Larsen Converse, Communications Director, Wisconsin Initiative on Climate Change Impacts.

Filamentous algal blooms in clear lakes

Unexpected and often unexplained proliferations of filamentous algae are increasingly common on the bottom of clear lakes, as reported in our article in BioScience. Usually, these filamentous algal blooms (FABs) are composed of green algae (chlorophytes), which have a distinctive chartreuse color and form extensive mats growing from the bottom (benthic) habitat of the lake into the water column (see inset, Lake Michigan). Filamentous algae are a normal part of benthic communities in lakes, but these expansive proliferations appear to be an emerging threat to some of the world's most iconic lakes.

We immediately suspect nutrient pollution when faced with algal blooms. But FABs are not common in eutrophic lakes because benthic filamentous algae require a lot of light and do not proliferate when shaded by abundant phytoplankton. FABs occur in water with extremely low nutrient concentrations, but nevertheless, nutrients are sometimes the culprit. In the Laurentian Great Lakes, invasive mussels promote FABs by filtering the water clean of phytoplankton and simultaneously excreting nutrients on the lake bottom. In Lake Baikal, untreated sewage or polluted groundwater percolating through the lake bottom causes massive FABs. The algae often foul beaches (background photo). In order to understand and control FABs, scientists need to start monitoring nutrients in more than just the water column.

Background photo shows algal washup on shore of Lake Baikal, courtesy of Oleg Timoshkin. Inset photo shows fiilemantous algae on the bottom of Lake Michigan, courtesy of Harvey Bootsma.

FABs are not just associated with groundwater pollution. Complex interactions among climate change, lake hydrodynamics, and food webs are likely causing FABs. Reductions in winter ice cover and changes in the intensity of summer storms are changing physical conditions in the nearshore, while warmer temperatures and reductions in insect grazers may be facilitating the rapid growth of filamentous algae. The nearshore habitat supports most of the biodiversity in lakes, and most human interactions with lakes occur along the shoreline. Despite this, littoral habitats are rarely studied. A coordinated effort between scientists and the public is needed to respond to this emerging threat to clear lakes.

By Yvonne Vadeboncoeur, Wright State University.

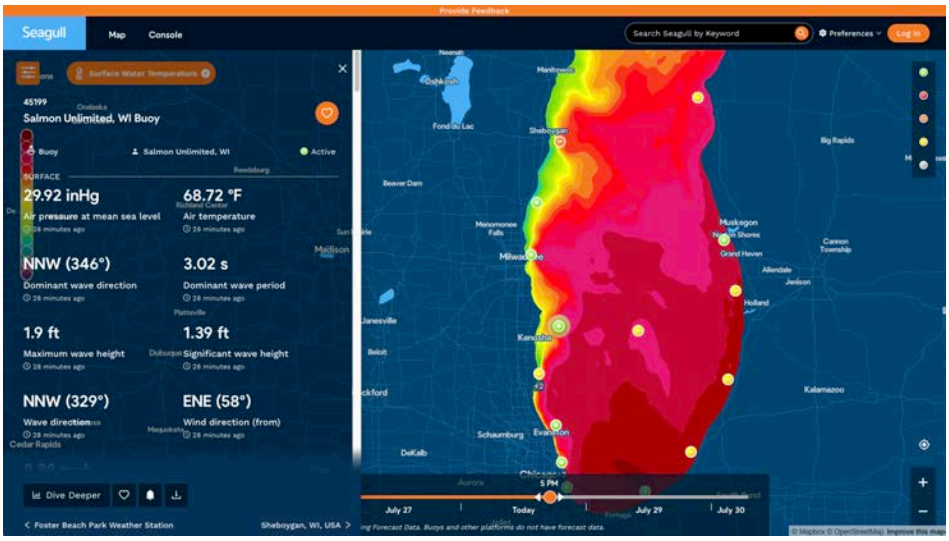
Newly launched, Seagull serves Great Lakes monitoring data

Scientists, boaters, resource managers, and others are using the next-generation data platform from the Great Lakes Observing System (GLOS) to see data from all five Great Lakes, and it goes beyond displaying only real-time buoy data.

GLOS is the certified Great Lakes node of NOAA's Integrated Ocean Observing System (IOOS) program, and for years, dozens of generous researchers and organizations have shared data with the wider region through GLOS, whether the data were from a buoy, weather station, forecast model, or another source. Hundreds of thousands of people benefit each year, accessing the information through always-free, public GLOS apps like GL Buoys and the HABs Portal.

With the demands on the aging system growing, in 2021 GLOS released a beta version of Seagull, a new, cloud-based IoT platform. The new system is built to be scalable, more stable, and capable of integrating with other systems so others can build technologies using the data. Over 300 beta testers helped refine Seagull, and in late April, Seagull officially launched at Glosapalooza in Chicago.

Seagull now displays data from a wide variety of real-time stations, several NOAA model layers, and some historical datasets, all open to the public, for free, using a real-time data system that's IOOS-certified. Over 55,000 people have used the platform, with many creating accounts to personalize the experience or receive custom alerts. Next, GLOS plans to expand the platform to support moving systems like gliders and drifters, high-frequency radar, additional forecast models, and more.



Seagull ingests data securely via HTTPS for many platforms, like this buoy operated by University of Wisconsin-Milwaukee near Racine. Users can view the data in real-time alongside NOAA model layers, such as for surface water temperature.

"This summer has been a rigorous test of the platform, with our team releasing new functionality, taking in feedback, fixing bugs, and working with people to connect new devices and datasets," says Tim Kearns, GLOS chief information officer. "Through all this, we're working toward the Smart Great Lakes vision of shared data and technology that informs science and policy in this incredible region."

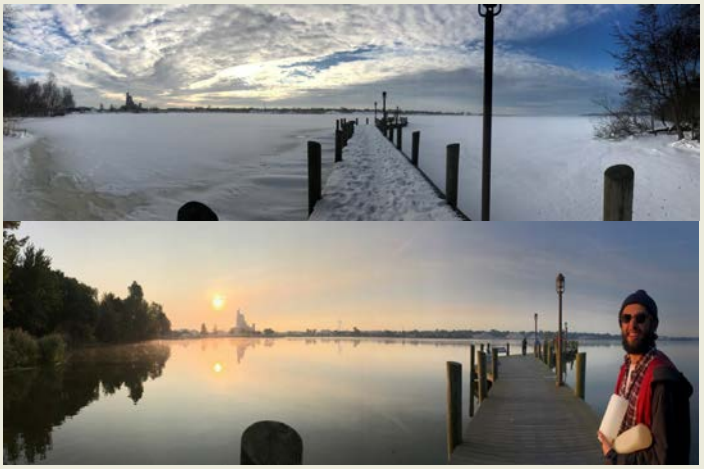
Anyone interested in connecting to Seagull or who has questions can learn more on our website, or email GLOS at support@glos.org.

~ By David Fitch, GLOS

Hope College forms Global Water Research Institute

Hope College, in Holland, Michigan, launched the Global Water Research Institute in March. Hope faculty and students have been engaged in water-related research for decades, for instance studying rainwater in the 1960s and Lake Macatawa in the 1990s. The GWRI builds on this history, bringing a variety of existing groups together to enable water-centered research that can transform the health and well-being of local, regional, and global communities. The interdisciplinary, collaborative student and faculty research provides improved understanding of water and equips communities to make data-driven decisions about their water use.

GWRI research areas span a wide range of activities. A few examples include studying microplastics and excess nutrients in the Macatawa Watershed and Lake Michigan, monitoring wastewater for the SARS-CoV-2 virus, and analyzing contaminants in drinking water for communities ranging from northern Indiana to Kenya. The initial GWRI fellows include 10 faculty from the departments of biology, chemistry, geological and environmental science, mathematics, political science, and religion, and Hope College's new Global Health Program. Initial funding for the institute has been provided through a lead gift from Sawyer Products and the Sawyer Foundation, founded by Kurt Avery. Co-directed by Aaron Best and Brent Krueger, the GWRI is seeking additional gifts to build an endowment for long-term support.



One project within the GWRI involves high frequency and long-term sampling of the Macatawa watershed. These photos show one sampling site on Lake Macatawa in winter and in summer. Photos by Sarah Brokus.

~ By Brent Krueger, Hope College

Lakes Letter is published quarterly by the International Association for Great Lakes Research, a scientific organization made up of researchers studying the Laurentian Great Lakes, other large lakes of the world, and their watersheds, as well as those with an interest in such research.

It is edited by IAGLR Communication Director Paula McIntyre with assistance from Alex Duncan and Jessica Ives, members of the *Lakes Letter* editorial team.

IAGLR 2023

We're hiring!

We're seeking a **conference coordinator** to lead the logistics of the association's annual Conference on Great Lakes Research, starting with next year's conference in Toronto.

Interested? View the job description on the IAGLR website. **Apply by September 19** to ensure consideration.

HOST AN IAGLR CONFERENCE!

Each spring, we hold our *Conference on Great Lakes Research* at a site alternating between Canada and the United States. We're currently looking for a U.S. host for the 2024 conference. The IAGLR Board of Directors considers proposals from host institutions based on the following criteria:

1. proposed scientific program and workshops,
2. conference facilities and logistics,
3. strength of conference team, and
4. location.

If you're interested in hosting a future conference, contact the Conference Committee co-chairs Mary Ginnebaugh and Noel Urban at confchair@iaglr.org.

We'd love to hear from you!